

CLAIMS

1. A process for fabricating a thin-film device,  
said process comprising the steps of:

5 forming a conducting layer composed of an  
anodically oxidizable metal on a substrate;

etching said conducting layer to form a  
plurality of bus lines having upper surfaces parallel to  
said substrate and inclined side surfaces and connection  
portions electrically connected to said bus lines and  
10 having upper surfaces parallel to said substrate and  
inclined side surfaces; and

anodically oxidizing said bus lines and  
said connection portions so that said bus lines and said  
connection portions include inner conducting portions and  
15 outer insulating oxide films covering said inner  
conducting portions, respectively.

2. A process according to claim 1, wherein said  
etching step is carried out so that the side surfaces of  
said bus lines and the side surfaces of said connection  
20 portions are inclined at angles within the range from 20  
degrees to 60 degrees, an average, with respect to said  
substrate.

3. A process according to claim 2, wherein said  
etching step is carried out so that the side surfaces of  
25 said bus lines and the side surfaces of said connection  
portions are inclined at angles within the range from 30  
degrees to 50 degrees, an average, with respect to said  
substrate.

4. A process according to claim 1, further  
30 comprising the step for forming a mask on said conducting  
layer prior to said etching step, and the step for ashing  
said substrate including said mask between said mask  
forming step and said etching step.

5. A process according to claim 1, further  
35 comprising the step for forming a mask on said conducting  
layer and the step for baking said mask prior to said  
etching step, wherein the temperature for baking said

mask in said baking step is so set that said mask will have a relatively small rigidity so that an outer portion of said mask is pushed up from said conducting layer due to a reaction gas in said etching step.

5           6. A process according to claim 5, wherein the temperature for baking said mask in said baking step is not higher than 115°C.

10           7. A process according to claim 5, wherein said etching step is carried out so that the side surfaces of said bus lines and the side surfaces of said connection portions are outwardly convex.

15           8. A process according to claim 5, wherein said etching step is carried out so that the angles between the upper surfaces and the side surfaces of said bus lines and of said connection portions are obtuse angles.

20           9. A process according to claim 1, further comprising an ionic milling step for removing part of the outer oxide films to expose the inner conducting portions after said step of anodic oxidation.

25           10. A thin-film device comprising at least a substrate, a plurality of bus lines provided on said substrate, and connection portions electrically connected to said bus lines, said bus lines and said connection portions being formed of an anodically oxidizable metal and having upper surfaces parallel to said substrate and inclined side surfaces, respectively, said bus lines and said connection portions including inner conducting portions and outer insulating oxide portions formed by anodic oxidation to cover said inner conducting portions, respectively.

30           11. A thin-film device according to claim 10, wherein said thin-film device is a substrate including thin-film transistors.

35           12. A thin-film device according to claim 11, wherein the substrate including said thin-film transistors is a substrate of a liquid crystal display device, said bus lines are gate bus lines, and said

connection portions are gate electrodes of said thin-film transistors, said thin-film device further comprising an insulating layer covering said bus lines and said connection portions, a plurality of drain bus lines  
5 arranged on said insulating layer to cross said gate bus lines, and a plurality of pixel electrodes.

13. A thin-film device according to claim 12, further comprising storage capacitor electrodes arranged on said substrate and made of the same material as said  
10 gate bus lines and said connection portions.

14. A thin-film device according to claim 10, wherein said thin-film device is an MIM diode.

15. A thin-film device according to claim 10, wherein said anodically oxidizable metal comprises at least one selected from the group consisting of Al, Ta, Al-Si, Al-Ta, Al-Zr, Al-Nd, Al-Pd, Al-W, Al-Ti, Al-Ti-B, Al-Sc, Al-Y, Al-Pt, and Al-Pa.

16. A thin-film device according to claim 10, wherein the side surfaces of said bus lines and the side  
20 surfaces of said connection portions are inclined at angles within the range from 20 degrees to 60 degrees, on average, with respect to said substrate.

17. A thin-film device according to claim 16, wherein the side surfaces of said bus lines and the side  
25 surfaces of said connection portions are inclined at angles within the range of from 30 degrees to 50 degrees, on average, with respect to said substrate.

18. A thin-film device according to claim 10, wherein the side surfaces of said bus lines and the side  
30 surfaces of said connection portions are outwardly convex.

19. A thin-film device according to claim 10, wherein the angles between the upper surfaces and the side surfaces of said bus lines and of said connection  
35 portions are obtuse angles.

20. A thin-film device according to claim 10, wherein at least two outer oxide films of said bus lines

and said connection portions contact each other and the contacting outer oxide films electrically isolate the inner conducting portions covered by said contacting outer oxide films.

5           21. A thin-film device according to claim 10,  
wherein a conducting portion separate from said bus lines  
and said connecting portions is arranged close to said  
bus lines or said connecting portions; said separate  
conducting portion includes an inner conducting portion  
10 and an outer insulating oxide portion covering said inner  
conducting portion; the outer oxide film of said separate  
conducting portion contacts at least one outer oxide film  
of said bus lines and of said connection portions; and  
said contacting outer oxide films electrically isolate  
15 the inner conducting portions that are covered by said  
contacting outer oxide films.

22. A process for fabricating a thin-film device,  
said process comprising the steps of:

forming a conducting layer composed of an  
20 anodically oxidizable metal on a substrate;

etching said conducting layer in a  
predetermined shape;

forming a second oxide film on said  
conducting layer by anodic oxidation after a first oxide  
25 film with a thickness is formed on said conducting layer;  
and

washing said substrate, whereby said first  
oxide film is removed by said washing and said second  
oxide film is not removed by said washing but remains on  
30 said conducting layer so as to cover said conducting  
layer.

23. A process according to claim 22, wherein said  
anodically oxidizable metal includes at least one of Al,  
Ta, Al-Si, Al-Ta, Al-Zr, Al-Nd, Al-Pd, Al-W, Al-Ti, Al-  
35 Ti-B, Al-Sc, Al-Y, Al-Pt, and Al-Pa.

24. A process according to claim 22, wherein said  
first oxide film is one of a naturally oxidized film or a

hydrated film formed on the surface of said anodically oxidizable metal.

25. A process according to claim 22, wherein said first oxide film has a thickness from 50 nm to 100 nm.

5        26. A process according to claim 22, wherein said washing step is executed using ultrasonic waves of not lower than 200 KHz.

10       27. A process according to claim 22, wherein said thin-film device is a substrate including thin-film transistors.

15       28. A process according to claim 27, further comprising a step for forming an insulating film on said substrate and a step for forming a semiconductor layer on said substrate after the second oxide film has been formed, wherein the step for etching said conducting layer forms gate electrodes and gate wirings.

20       29. A process according to claim 27, further comprising a step for forming a semiconductor layer on said substrate and a step for forming an insulating film on said substrate prior to forming said conducting layer, wherein the step for etching said conducting layer forms gate electrodes and gate wirings.

25       30. A process according to claim 22, wherein the step for etching said conducting layer forms gate electrodes having upper surfaces parallel to said substrate and inclined side surfaces.

31. A process for fabricating a thin-film device, said process comprising the steps of:

30                forming a semiconductor layer having a predetermined shape on a substrate;

                 forming an insulating film on said substrate to cover said semiconductor layer;

35                forming a conducting layer composed of an anodically oxidizable metal on said substrate in such a shape as to cover a portion of said semiconductor layer and to form gate electrodes having upper surfaces parallel to said substrate and inclined side surfaces;

anodically oxidizing said gate electrodes;  
forming said insulating film into a  
predetermined shape using said gate electrodes including  
the anodically oxidized film as a mask; and

5 injecting impurities into said  
semiconductor layer using said gate electrodes including  
said anodically oxidized film and said insulating film as  
a mask to form an offset in said semiconductor layer.

10 32. A process according to claim 31, wherein said  
thin-film device is a substrate including thin-film  
transistors.

15 33. A process according to claim 31, wherein said  
anodically oxidizable metal includes at least one of Al,  
Ta, Al-Si, Al-Ta, Al-Zr, Al-Nd, Al-Pd, Al-W, Al-Ti, Al-  
Ti-B, Al-Sc, Al-Y, Al-Pt, and Al-Pa.

34. A process according to claim 31, wherein said  
anodically oxidized film is a barrier-type anodically  
oxidized film.

20 35. A process according to claim 31, wherein said  
semiconductor layer comprises a polycrystalline silicone.

36. A process according to claim 31, wherein an  
initial current density at the time of executing the  
anodic oxidation is not smaller than  $2.0 \text{ mA/cm}^2$  but is  
not larger than  $3.0 \text{ mA/cm}^2$ .

25 37. A process according to claim 31, wherein the  
step for forming said gate electrodes comprises the step  
for forming a gate electrode layer and the step of  
patterning the gate electrode layer based on either ionic  
milling or dry-etching.

30 38. A process according to claim 31, wherein a  
masking resist is formed on said conducting layer and is  
post-baked at a temperature of not lower than  $130^\circ\text{C}$  but  
not higher than  $200^\circ\text{C}$ , prior to forming said gate  
electrode.

35 39. A thin-film device comprising a substrate, a  
semiconductor layer formed in a predetermined shape on

said substrate, an insulating film covering a portion of  
said semiconductor layer, a gate electrode formed on said  
insulating film, and an anodically oxidized film of said  
gate electrode formed on said insulating film so as to  
5 cover said gate electrodes, said anodically oxidized film  
having a shape as viewed from above which is identical to  
the shape of said insulating film as viewed from above  
and having an annular portion in annular contact with  
said insulating film about said gate electrode, a portion  
10 of said semiconductor layer located on the outer side of  
said insulating film forming a source electrode and a  
drain electrode, and a portion of said semiconductor  
layer covered by said annular portion of said anodically  
oxidized film forming an offset on the inner side of said  
15 insulating film.

40. A liquid crystal display device, comprising:  
a first substrate comprising the thin-film  
device having a plurality of thin-film transistors  
according to claim 10 or 39;  
20 a second substrate opposite to the first  
substrate; and  
a liquid crystal layer filled between the  
first and second substrates.